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Linux Stateless Video Decoder Support

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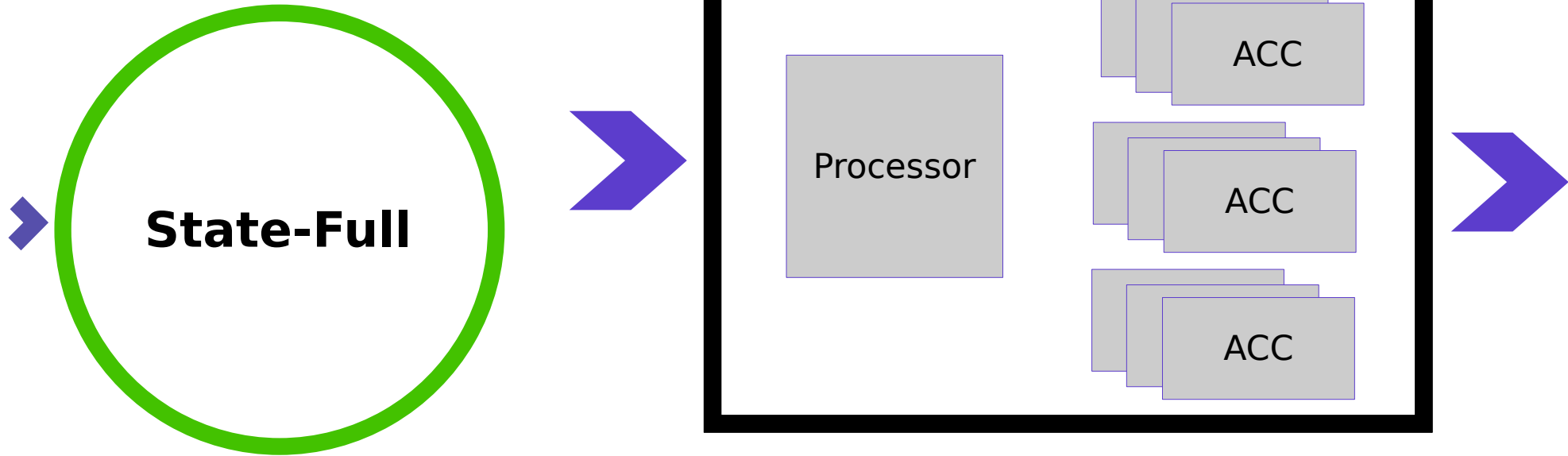
About me

- Over 10 years at Collabora
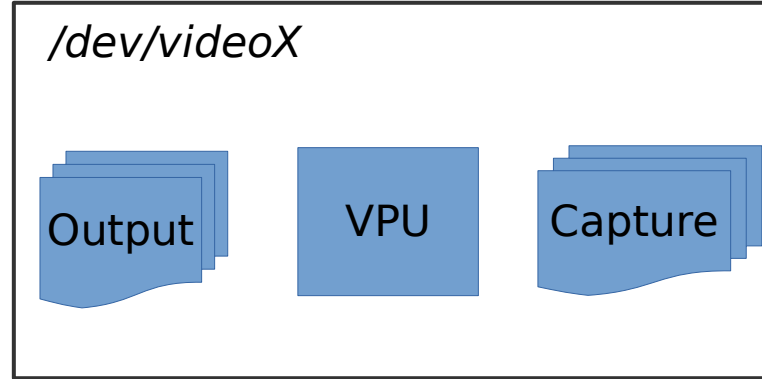
- Core GStreamer developer

- Contribute to Linux Media

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The beginning of Linux CODECs

2011

- Google partners with Samsung and Asus

- Produce the first ARM Chromebook

- Based on Exynos 5 SoC

- Includes Samsung MFC Decoder

- MFC V4L2 M2M driver landed mainline

State-Full

Processor

ACC

ACC

ACC

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/dev/videoX

Output   VPU   Capture

V4L2 M2M

- A V4L2 output queue is used for the bitstream

- A V4L2 capture queue is used for the decoded pictures

- Additional control flow are added to support draining, flushing

- Inter-queue configuration flow is needed

Pros

Cons

- Minimal per CODEC code needed

- Requires a firmware

- Harder to multiplex

CODA Driver

2014

- CODA driver was added
  - Design from Chips&Media
  - CODA Hx4 and 960 support
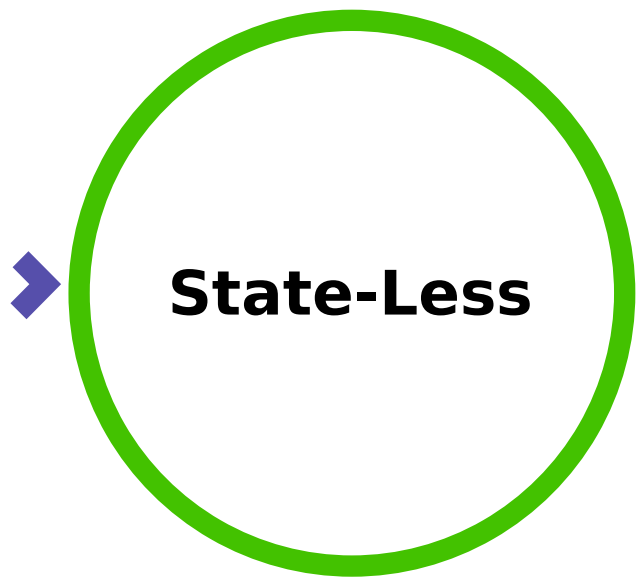- Enabling i.MX51 and i.MX6
- Reversed engineering

**The beginning of Linux
State-Less CODECs**

2015

- Google partners with Rockchip

- 2nd gen of ARM Chromebook

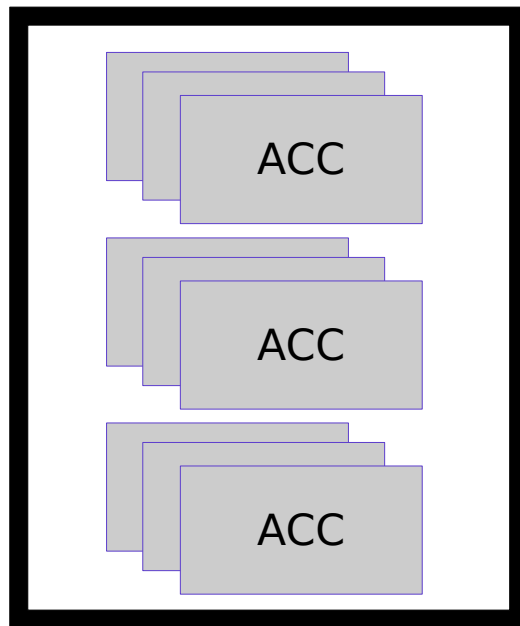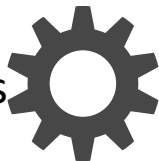- New type of CODEC hardware

- Rockchip VDPU ?

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State-Less

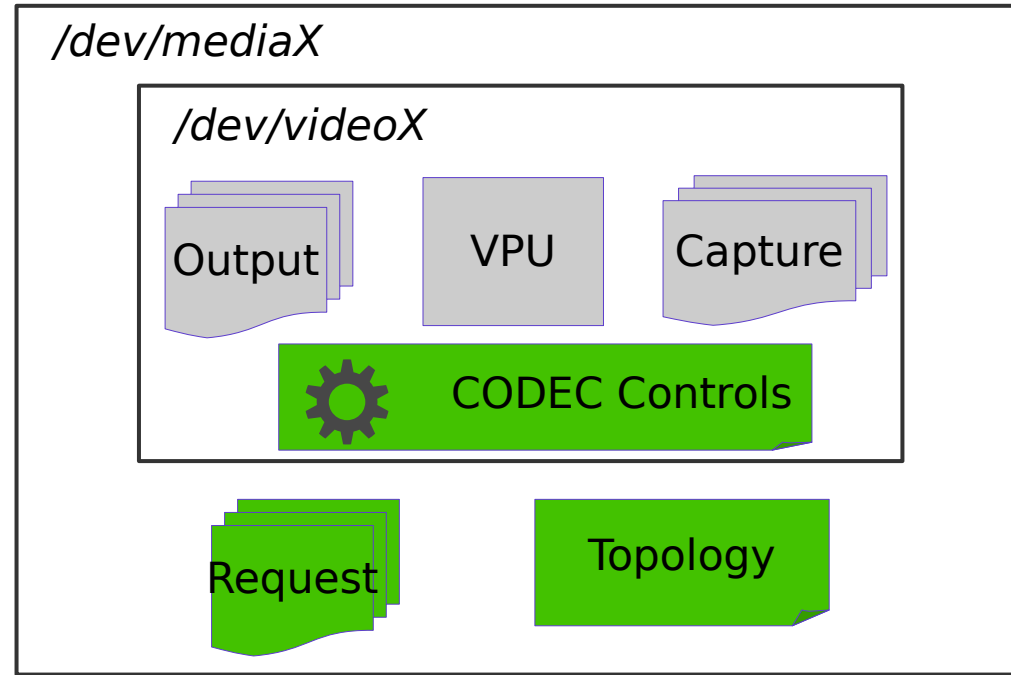Reference(s)

Bitstream

Parameters

ACC

ACC

ACC

Picture

GPU

- Registers are replace with a command as part of the command stream

- Crafting command stream is HW specific and is only implement in userspace drivers (Mesa)

- Commands are scheduled by the GPU driver

- Exposing VPU in Mesa is done through standards API (VA API, VDPAU, DXVA2, NVDEC), but without a GPU, using these APIs can be cumbersome and overkill

- Using multiple GPU hardware in the same application remains tedious

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**V4L2 M2M
+
Request**

/dev/mediaX

/dev/videoX

Output   VPU   Capture

⚙ CODEC Controls
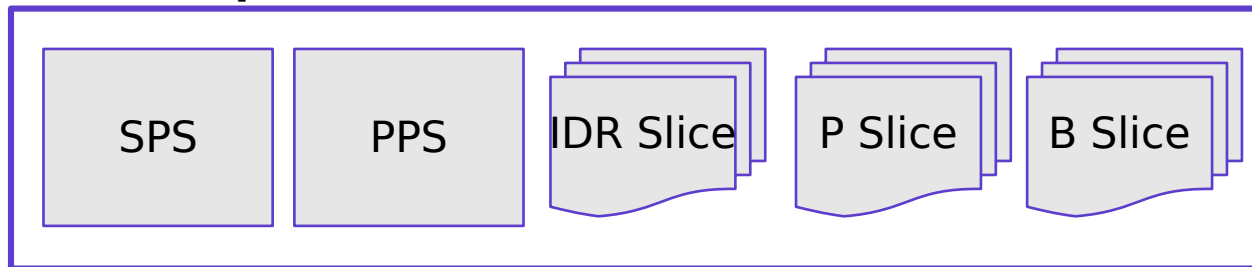
Request   Topology

- Per-frame (or slice) controls are associated with bitstream buffers using requests

- References are signaled using user defined timestamps

- Better identification can be done using the Media Controller topology

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H.264

NALU Sequence

| SPS | PPS | IDR Slice | P Slice | B Slice |

Annex B NALU

Start-Code (0x000001) | **HDR** **Payload**

AVCc NALU

Size | **HDR** **Payload**

Decoding process

- Locate and parse NAL headers
- Parse non-VLC and VCL NAL (SPS, PPS, Slice Headers)
- Calculate frame_num (and handle gaps)
- Calculate POC and pic_num
- (Sliced Base) prepare reference lists
- ….

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Decoding process (continued)

- Fill SPS / PPS, Decode parameters, Slice params V4L2 structures

- (Slice Based) Modify reference lists

- Decode the slices/frame

- Do DPB management as per spec

- Output frames that could be re-ordered

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V4L2 Specific Process

- Allocate a Request (an FD)
- Set per-frame/slice params for this request
- Queue a v4l2_buffer for the request
- Queue the request
- Poll the request FD for completion

MediaTek VPU

2016

- State-full H.264, VP8 and VP9 decode

- Tiled output only (requires HW converter)

Qualcomm Venus

2017

- State-full MPEG4, MPEG2, H.264, VC1, H.264, VP8, VP9 and HEVC decode

- MPEG4, H.263, H.264, VP8, HEVC

Upstreaming Stalled

- Could not settle on the Request / Job API

- Low knowledge of CODEC decoding process by the linux-media maintainers

- Only one hardware to test the API design

- No formal specification (not that state-full CODEC had any either)

Allwinner VPU support Kickstarter by Bootlin

2018

- Request API is finalized

- MPEG2 Support landed in Staging

- H.264 support was progressing (but only sliced based)

- Reversed engineered from binary userspace blob

- VAAPI userspace drivers

2019

- The crowd funding had gain good momentum

- A formal specification was merged

- H264, VP8, HEVC uAPI added as staging control API

- Cedrus gained H264 and HEVC support

- RK3288 driver was mainlined (MPEG2, H264, VP8)

- RK3288 driver was renamed !?!

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The Hantro Driver

- I.MX8M Quad, using Hantro G1/G2
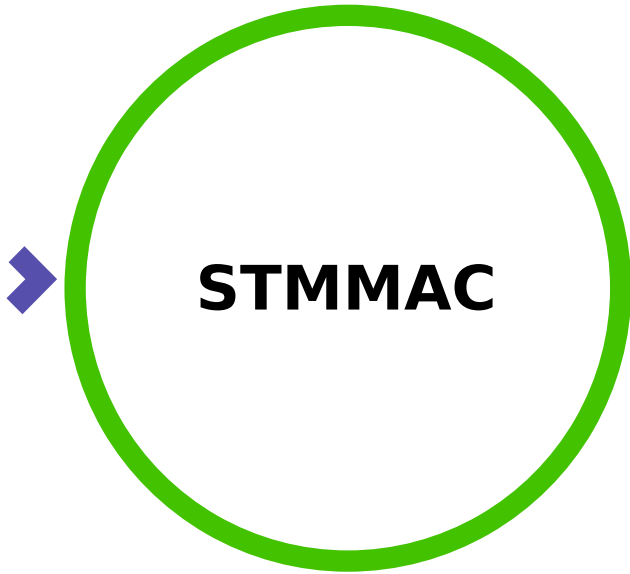
- Registry compatible with the RK3288

ZODIAC AEROSPACE

STMMAC

- `stmmac` is an ethernet driver, that was thought to be an STM design

- It was later found to be DesignWare design, shared across numerous SoC

- Still called `stmmac` to maintain kernel API stability

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Testing and Fixing

- FFMPEG support

- Bug fixing

- Interlaced Content Support

2020

- RK3399 JPEG, MPEG2, H.264 and VP9 support landed

- GStreamer gained base classes for state-less CODEC, with already merge DXVA2 and NVDEC support

- **GStreamer** H.264 and VP8 V4L2 support landed

- Embedded World Conference 2020 **canceled**

- VA V4L2 Request driver was abandoned

- And a lot more coming ...

- (at 2m distance of course)